Analysis of tagging data of the toothfish (*Dissostichus eleginoides*) resource in the Prince Edward Islands vicinity

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SUMMARY

Some simple analyses of the tag-recapture data available for the PEI toothfish resource are undertaken. Somatic growth rate seems to be less than that in Subarea 48.3 which has previously been assumed for assessments of the PEI resource. If the first two years of data for each vessel are excluded, broad indications are that the tag recovery efficiency on the two vessels operating in the fishery are about the same and not changing over time.

INTRODUCTION

At a Task Group Meeting held on 7 March concerning the Prince Edward Islands (PEI) toothfish (*Dissostichus eleginoides*) several tasks were identified in order to advance the development of a Management Procedure for this resource. Two of those tasks are addressed in this paper. These are:

a) to use available tag-recapture data to coarsely estimate somatic growth rate, and
b) to evaluate PEI toothfish data for possible between-vessel differences in tag recovery rates.

DATA UPDATES

Tagging data of toothfish in PEI from 2005 to 2016 are used in this paper.

METHODOLOGY

Growth curve

The von Bertalanffy growth model of the body length as a function of age of a fish is given by:

$$L(t) = L_\infty\left(1 - e^{-\kappa(t-t_0)}\right),$$

where

$L(t)$ is the length of a fish at age t,

L_∞ is the mean asymptotic length of the oldest fish,

κ is the curvature parameter that determines how fast a fish will reach its L_∞ value, and

t_0 is the age at which the fish has zero length.

From this equation it follows that:

$dL/dt = \kappa(L_\infty - L(t))$, so that the relationship between the instantaneous growth rate as a function of length is linear, where the growth rate of a fish can be approximated by:

$$\frac{\Delta L}{\Delta t} = \frac{L(t+\Delta t) - L(t)}{\Delta t},$$

where

$L(t+\Delta t)$ is the length of a fish at recapture,

$L(t)$ is the length of the fish at release, and

Δt is the time at large of the fish, in units of years.

so that

$$\frac{\Delta L}{\Delta t} = \kappa\left(L_\infty - L(t)\right) = a + bL(t),$$

with $\kappa = -b$ and $L_\infty = -a/b$.

Vessel differences in tag recovery rates

We define the efficiency of tag recovery by a vessel (v) in year t by:

$$E_{v,t} = \frac{R_{v,t}/C_{v,t}}{N_{tags}(t)}, \text{ where}$$

$R_{v,t}$ is the number of tags recaptured by vessel v in year t,

$C_{v,t}$ is the catch in numbers by vessel v in year t, and

$N_{tags}(t)$ is the number of tags at large in year t and is given by:

$N_{tags}(t) = \left[N_{tags}(t-1) - R_{recap}(t-1) \right] e^{-M} + N_{tags}^{new}(t)$, where

$R_{recap}(t)$ is the number of tags recaptured in year t, and

$N_{tags}^{new}(t)$ is the number of new tags released in year t. In the equation for the number of tags at large, the fishing mortality is assumed to be zero as the fishing mortality estimated by the assessment model for toothfish is rather small relative to the natural mortality rate.

Results and Discussion

The regression line fitted to the growth rate together with 95% confidence interval and 99% prediction intervals (3 standard deviations) is shown in Figure 1. Outliers that fell outside 3 standard deviations of the regression line were omitted from the final regression fit. Table 1 shows the growth parameter values (Agnew *et al*., 2006) assumed in the assessments conducted, which are based upon the values for Subarea 48.3 and those estimated from tagged toothfish in PEI. Figure 2 compares the growth rate obtained by these 2 sets of parameters. While we hesitate to suggest that this regression fit should be accepted for providing revised growth curve parameters for the PEI toothfish, the fact that the growth curve used previous falls outside the 95% CI for this newly estimated curve does suggest that assessments should consider a slower rate of growth than assumed in the past, at least as a sensitivity.

Figure 3 compares the vessel efficiency of *El Shaddai* and *Koryo Maru* assuming a natural mortality of 0.13 (as assumed by the assessment model) and of 0.2 (to include possible tag loss, etc.). Approximate 95% Cis are based on the assumption that *R* is Poisson distributed. In very broad terms the recovery efficiencies seem roughly constant and about the same for the two vessels, though low values for the majority of the first two years for the two series suggest that those early results might. reflect "learning" in some way and might better be discarded from analyses.

Reference

Agnew, D.J., Hillary, R., Belchier, M. Clark, J. and Pearce, J. 2006. Assessment of toothfish in Subarea 48.3, 2006. Commission for the Conservation of Antarctic Marine Living Resources Subgroup on Assessment Methods Document: WG-FSA-06/53.

Acknowledgements

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Table 1. Growth parameter values ("old" -Agnew *et al.*, 2006) assumed for the past assessments conducted for the PEI toothfish, based upon the values for Subarea 48.3,and those ("new") estimated from tagged toothfish in the PEI.

Parameter	"Old" Value	"New" value
von Bertalanffy growth		
ℓ_∞ (cm)	152.0	197
κ (yr^{-1})	0.067	0.018

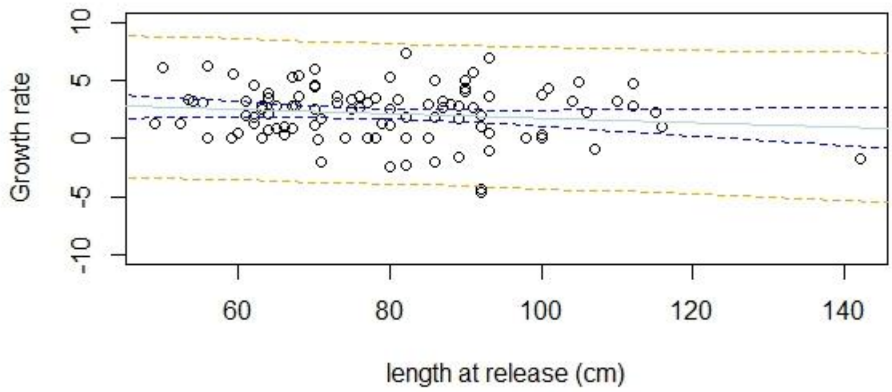

Figure 1. Fitted annual growth rate together with 95% confidence interval and 99% prediction intervals (length units are cm).

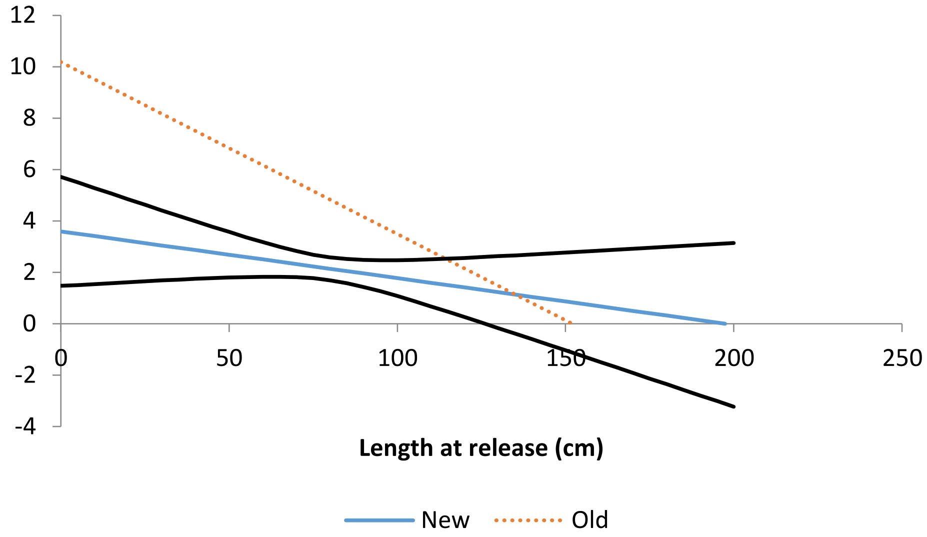

Figure 2. Comparison of the “old” growth rate obtained by the growth parameters of Agnew *et al*., (2006) and that (“new”) estimated from tagging data from toothfish in the PEI vicinity, together with it’s 95% confidence interval.

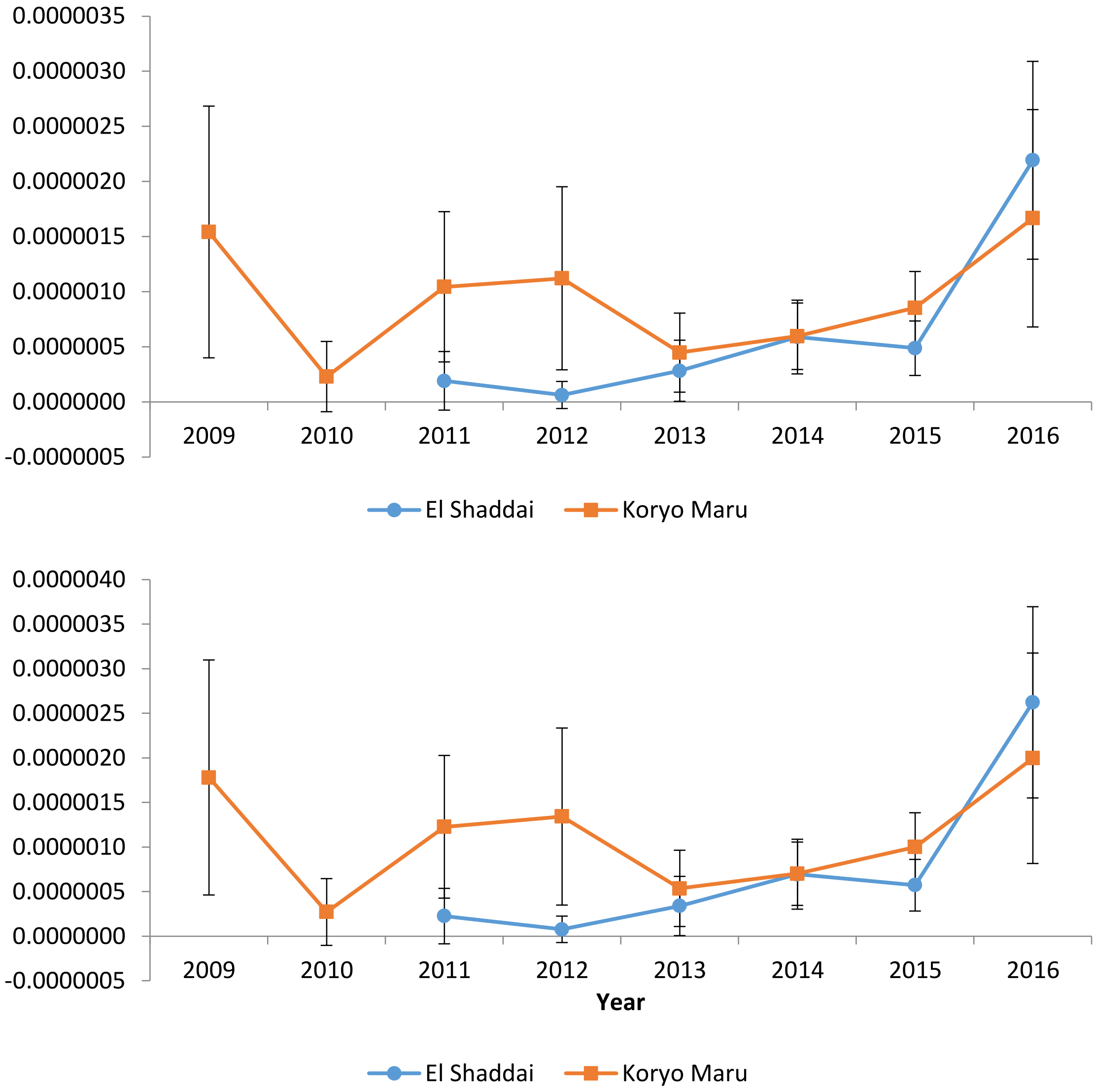

Figure 3. Comparison of the efficiency of tag recovery by the vessels *El Shaddai* and *Koryo Maru* assuming a natural mortality of 0.13 (top) and 0.2 (bottom), together with approximate 95% confidence intervals.